MOTOR

BACKGROUND OF INVENTION

Field of the Invention

The present invention relates to a motor well adaptable for a CD-ROM driver, a DVD-ROM drive or others.

Related art

A brushless motor, disclosed in JP-A-8-331820, has been known for a motor used for the CD-ROM drive, for example. The brushless motor follows. A rotary shaft is supported with aid of a radial bearing as a sintered oil-impregnated bearing and a thrust plate within a cylindrical bearing housing. The radial bearing is located in the upper portion of the bearing housing. The inside diameter of the lower part of the bearing housing is larger than that of the upper part thereof. A dish-like thrust cap is mounted on the lower part of the bearing housing. A thrust plate is disposed between the lower end of the rotary shaft and the thrust cap.

The motor is capable of preventing bearing lubricating oil from flowing out of a thrust receiving portion since the dish-like thrust cap is mounted on the lower part of the bearing housing, and a thrust plate is disposed between the lower end of the rotary shaft and the thrust cap. In the radial bearing fixed to the bearing housing, the lubricating oil receives a pumping action with rotation of the shaft, and flows downwardly of the inner wall of the bearing housing. The oil thus flowing out reaches a portion

where the thrust cap is attached to the bearing housing. Even if the thrust cap is attached in press fitting manner, a minute gap will possibly be formed between the cap and the housing since those members are separate members. If such a gap is present, oil will leak through the gap outside the thrust cap.

When a disc is attached to the disc hub integral with the rotary shaft, a force is applied to the fixing portion for the thrust cap and the bearing housing in a direction in which the thrust cap is pulled out. As a result, the oil is likely to flow outside from the fixing portion.

SUMMARY OF INVENTION

Accordingly, an object of the present invention is to provide a motor which is free from the flowing of bearing lubricant oil outside the bearing housing, and has a long lifetime and a high reliability.

An aspect of the present invention, there is provided a motor comprising:

a cup-like bearing housing integrally including a cylindrical portion, a bottom portion and a hollow portion defined by said cylindrical portion and said bottom;

a radial bearing held in said hollow portion while being in contact with the inner surface of said cylindrical portion;

a thrust receiving plate disposed at said bottom portion of said cup-like bearing housing; and

a rotary shaft rotatably supported by said radial bearing in a state that an extreme end thereof is in contact with said thrust receiving plate.

In the present invention, the bearing housing, which is shaped like a cup, includes a cylindrical portion and a bottom portion closing one end of the cylindrical portion. Therefore, in the resultant motor, no bearing oil flows outside from the bottom portion of the bearing housing.

Shaping a metal sheet by drawing process forms the bearing housing. Therefore, the number of parts required is reduced. The unit form of the bearing housing eliminates the leakage of bearing oil out of the housing.

A gap, which may be utilized for an oil reservoir, is formed between the inner surface of the cylindrical portion of the bearing housing and the outer surface of the radial bearing. Provision of the gap prevents the bearing oil from leaking out of the bearing housing, elongates a lifetime of the motor, and allows bearing oil replenishment at the time of assembling the rotor into the structure.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a cross sectional view showing a portion of a motor which constitutes a first embodiment of the present invention.

Fig. 2 is a cross sectional view showing a portion of another motor which constitutes a second embodiment of the present

invention.

Fig. 3 (a) and Fig. 3(b) are cross sectional views showing a bearing housing which may be used for the motor of the invention.

Fig. 4 is a perspective view showing a burring portion which may be used for the motor of the invention.

Fig. 5 is a cross sectional view showing a way of assembling a bearing assembly, which may be used for the motor of the invention.

Fig. 6 is a cross sectional view showing a thrust bearing assembly which may be used for the motor of the invention.

A ~~Fig. 7 is a side view~~ Fig. 7(a)–Fig 7(c) are side views. showing a way of assembling a stator assembly which may be used for the motor of the invention.

Fig. 8 is a side view showing a way of assembling a rotor assembly which may be used for the motor of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The preferred embodiments of the present invention will be described with reference to the accompanying drawings. As shown in Fig. 1, a bearing housing 7 includes a cylindrical portion 21, a bottom portion 22 and a hollow portion 23. To form the bearing housing 7, a metal sheet is pressed into a cup-like shape having the cylindrical portion 21 and the bottom portion 22 closing one end of the cylindrical portion 21. A thrust receiving plate 8 is placed on the bottom portion 22 within the hollow portion 23 of the bearing housing 7 while being centered. A radial bearing 9 is disposed within the cylindrical portion 21 of the bearing housing

7 while being in contact with the inner surface (peripheral) of the cylindrical portion 21. A rotary shaft 1 is supported by the inner surface of the radial bearing 9 in a state that it is rotatable about its center axis. In this case, the rotary shaft 1 rotates in a state that a extreme end 24 of the rotary shaft 1 is in contact with the thrust receiving plate 8. In the present embodiment, the drawing process is used for shaping a metal sheet into the cup-like bearing housing 7 with the bottom portion 22. However, any other suitable process may be used for the same purpose, as a matter of course.

A hub 2 to which a disc is set is secured onto the upper end of the rotary shaft 1. A rotor case 3 is fastened to the under surface of the hub 2. A rotor magnet 4, cylindrically shaped, is fastened onto the inner surface of the rotor case 3. A stator core 5 is fit to the outer surface (peripheral) of the cylindrical portion 21 of the bearing housing 7, while being disposed facing the inner surface of the rotor magnet 4. The stator core 5 includes a plural number of protruding poles, which are radially extended and equiangularly disposed around the core. Each protruding pole has a drive coil 15 wound thereon. The rotor case 3, the hub 2 and the rotary shaft 1 are rotatable in unison.

The bearing housing 7 has a stepped part 26, which is located between its bottom portion 22 and an end face 28 of one end of the radial bearing 9. The inside diameter of an upper portion of the cylindrical portion 21 above the stepped part 26 is larger than

that of a lower portion of the cylindrical portion below the stepped part 26. The rotary shaft 1 includes a reduced-diameter portion 27, located between an extreme end 24 thereof closer to the thrust receiving plate 8 and an end face 28 of one end of the radial bearing 9. A washer 10 as ring-like slipping-off preventing means is placed between the stepped part 26 of the radial bearing 9 and the end face 28 of the radial bearing 9. The washer 10 engages the reduced-diameter portion 27 of the rotary shaft 1. Bringing the washer 10 into contact with the end face 28 of the radial bearing 9 reliably prevents the rotary shaft 1 from slipping off.

An upper portion of the bearing housing 7 above the stepped part 26 forms a bearing-fixing portion 32 the inside diameter of which is somewhat shorter than the outside diameter of the radial bearing 9. The radial bearing 9 is tightly inserted into the bearing-fixing portion 32 of the bearing housing 7. With this, The radial bearing 9 is fixedly supported with the bearing-fixing portion 32.

Another stepped part 34 is formed at a mid-position of the cylindrical portion 21 of the bearing housing 7. With provision of the stepped part 34, approximately the half of the axial length of the radial bearing 9 is held with the bearing fixing portion 32 of the bearing housing 7, which extends below the stepped part 34. A gap 33 is formed between the inner surface of the cylindrical portion 21 of the bearing housing 7 and the outer surface of the radial bearing 9. The gap 33 may be formed by selecting the inside

diameter of the cylindrical portion 21 located above the stepped part 34 to be larger that outside diameter of the radial bearing 9. In an alternative formation of the gap 33, the outside diameter of the upper portion of the radial bearing 9 is selected to be larger than the inside diameter of the cylindrical portion 21 without forming the stepped part 34 on the cylindrical portion 21 of the bearing housing 7. A radial distance of the gap 33 is selected to be at least 25μm, for example.

The gap 33 is utilized for an oil reservoir. When the rotary shaft 1 is rotated, oil is emitted from the radial bearing 9. The oil raises from the upper end face 35 of the radial bearing 9; flows to the outer periphery side of the radial bearing 9; stays in the rotor case 3; and returns to the radial bearing 9. It is noted here that the oil does not leak out of the bearing housing 7. This fact ensures a reliability and long lifetime of the resultant motor.

As shown in Fig. 4, a base plate 6 includes burring portions 39 formed by burring and core fixing portions 38 formed by bending a part of the base plate 6 in the vicinity of the burring portion 39. The core fixing portions 38 are angularly disposed at angular intervals each of 120° while being located each between the two adjacent the burring portions 39 being arranged in a ring-like fashion. Each core fixing portions 38 is shaped to include a vertical portion located outside the related burring portions 39 and a horizontal portion horizontally extending from the vertical portion toward a space between the related adjacent burring

portions 39. The bearing housing 7 is press fit into the arrangement of the burring portions 39; the outer surface of the cylindrical portion 21 of the bearing housing 7 is firmly held with the inner surfaces of the burring portions 39. Accordingly, a verticality of the bearing housing 7 with respect to the base plate 6 is secured by the arrangement of the burring portions 39. To this end, a length of the inner surface 41 of each of the thus arranged burring portions 39 is selected so as to secure the verticality of the bearing housing 7 with respect to the base plate 6. An upper surface 55 (as a disc placing surface) of the hub 2 may be adjusted since an axial position of the bearing housing 7, viz., a press-fitting height, of the burring portions 39 may be adjusted with respect to the inner surfaces 41 of the burring portions 39. The verticality of the bearing housing 7 with respect to the arrangement of the burring portions 39 is adjusted as intended and then in this state those are coupled together by welding or bonding.

The embodiment provides a stator core fixing structure with a high rigidity for the following reason. The upper surfaces 42 of the fixing portions 38 are brought into contact with the lower surface of the stator core 5; the height of the stator core 5 is adjusted; and the cylindrical portion 21 of the bearing housing 7 holds the inner surface of the stator core 5 in a compressive manner.

Fig. 5 is a cross sectional view useful in explaining a way of assembling a bearing assembly. As shown, a jig 51 is disposed

to guide the rotary shaft 1 for its centering, and the radial bearing 9 is inserted into the jig 51. A guide bar 52 is inserted into the radial bearing 9. The thrust receiving plate 8 is put on the top of the guide bar 52; the washer 10 is placed between the thrust receiving plate 8 and the end face 28 of one end of the radial bearing 9; and in this state, the bearing housing 7 shaped like a cup is press fit to the thus assembled structure. In this case, the bearing housing 7 is moved till its bottom portion 22 comes into contact with the thrust receiving plate 8. In this state, the outer surface of the radial bearing 9 is firmly fixed with the bearing-fixing portion 32 of the bearing housing 7. In actually assembling the rotor, the guide bar 52 is pulled out of the radial bearing 9 and the rotary shaft 1 is inserted into the same instead.

Fig. 3 is a cross sectional view of the bearing housing 7, taken line a – a in Fig. 5. Axially elongated grooves 31 are formed in the inner surface of the bearing housing 7. The grooves 31 communicates a space 29, which is formed by the end face 28 of one end of the radial bearing 9 and the bottom portion 22 of the bearing housing 7, with a space 30 located closer to the opening end of the bearing housing 7. Fig. 30A shows a cross sectional view of the bearing housing 7 in which three axially elongated grooves 31a semicircular in cross section are formed in the inner surface of the bearing fixing portion 32 while being equiangularly arranged. Fig. 3B shows a cross sectional view of the bearing housing 7 in which three axially elongated grooves 31b shaped like U in cross

section are formed in the inner surface of the bearing fixing portion 32 while being equiangularly arranged.

Another bearing housing 7 is shown in Fig. 6. The bearing housing 7 includes three axially elongated grooves 31c, which are formed in the outer surface of the radial bearing 9 while being arranged equiangularly. As recalled, in each of the above two bearing housings 7, the grooves axial grooves 31a (31b) are formed in the inner surface of the bearing housing 7. The size and the number of grooves may properly be selected in accordance with a kind of motor used.

Thus, at least one groove 31 is formed in the inner surface of the bearing housing 7 or the outer surface of the radial bearing 9. The groove 31 yields the following advantages. When the rotary shaft 1 is inserted into the radial bearing 9, air present in the space 29 in the vicinity of the bottom portion 22 of the bearing housing 7 is guided outside. Further, provision of the groove 31 prevents oil from overflowing through the edge of the radial bearing 9 when the rotary shaft 1 is inserted into the radial bearing 9.

A fixing strength of the outer surface of the radial bearing 9 may be adjusted to a necessary one in a manner that a balance between the outer surface of the radial bearing 9 with the bearing fixing portion 32 of the bearing housing 7 when those are in contact with each other is varied by varying the combination of the number and the size of the of the grooves 31 as oil-leak preventing means and the axial length of the bearing fixing portion 32 of the bearing

housing 7.

Further, with provision of the grooves 31 formed in the bearing-fixing portion 32 of the bearing housing 7 or in the outer surface of the radial bearing 9, part of oil moves to the washer 10 and the extreme end of the radial bearing 9. The oil present there functions to stabilize a frictional resistance between the thrust receiving plate 8 and the rotary shaft 1 for a long time.

Fig. 7 is a side view showing a way of assembling a stator assembly, which may be used for the motor of the invention. A bearing assembly formed by inserting the radial bearing 9 into the bearing housing 7, as shown in Fig. 7A, is forcibly inserted into the center hole of the stator core 5 in a state that the opening end of the assembly is directed upward. As a result, a close contact is established between the outer surface of the bearing housing 7 and the inner surface of the center hole of the stator core 5, and the former is fixed by the latter. As already stated, the base plate 6 includes the burring portions 39 formed by burring and the core fixing portions 38 formed by bending a part of the base plate 6 at a location near the burring portion 39. After forcibly inserted and fixed by the stator core 5, the bearing assembly is press fit into the hole defined by the burring portions 39 (Fig. 7B). Then, the outer (peripheral) surface of the cylindrical portion 21 of the bearing housing 7 is firmly held by the inner surfaces 41 of the burring portions 39, and the lower surface 53 of the stator core 5 is put on the upper surfaces 42 of the core

fixing portions 38, and positioned thereat (Fig. 7C). Incidentally, bearing oil may be put, for its replenishment, into the gap 33 located between the radial bearing 9 and the bearing housing 7 after the stator assembly is assembled.

A height H from the upper surface 54 (as a reference surface) of the base plate 6 to the disc placing surface 55 of the hub 2 is given by

$$H = A - B \qquad (1)$$

where A is a distance from the extreme end 24 of the rotary shaft 1 which is located closer to the thrust receiving plate 8 to the disc placing surface 55, and B is a distance from the reference surface 54 to the upper surface of the thrust receiving plate 8 (Figs. 1, 5, 7C and 8). The length of the rotary shaft 1, as shown in Fig. 8 determines the distance A. The distance B varies with a position of the bearing housing 7 when it is press fit into the burring portions 39 of the base plate 6 (Fig. 7C). (This position of the bearing housing 7 will be referred to a "fitting position".) From this, it is seen that the height H ranging from the reference surface 54 to the disc placing surface 55 may be adjusted by the "fitting position" of the bearing housing 7. It is noted here that the burring portions 39 holds the bearing housing 7 so as to allow the bearing housing 7 to be movable in the axial and circumferential directions. Therefore, adjusting the fitting position in an actual

assembling work can precisely set the height H.

As well known, to operate the thus constructed motor, electric current is fed to the drive coils in accordance with angular positions of the rotor magnet 4. Electromagnetic forces are developed between the stator core 5 and the rotor magnet 4. The rotor magnet 4, and the rotor case 3 and the hub 2, which are coupled together with the rotor magnet 4, are driven to rotate in unison.

The Fig. 1 motor described above includes the washer 10 as means for preventing the rotary shaft 1 from slipping off. Another rotor slipping-off means may be used as shown in Fig. 2. In a structure of the motor shown in Fig. 2, the rotor slipping-off preventing means 10 (Fig. 1) is not used; the bearing housing 7 does not include the stepped part 26; and the rotary shaft 1 does not include the reduced-diameter portion 27. Also in the Fig. 2 structure, a centering guide portion 40, while being protruded, is formed on the end face of the lower end of the radial bearing 9. The centering guide portion 40 is used for centering the thrust receiving plate 8.

As shown, a flange-like portion 36 is formed on the end of the bearing housing 7 at which the housing is opened. Rotor slipping-off preventing means 37 is extended from a horizontal part 3a of the rotor case 3, which is mounted on the under side of the hub 2, toward the flange-like portion 36. In a normal state of the motor, the upper surface 37a of the rotor slipping-off preventing means 37 is separated from the lower surface 36a of the flange-like

portion 36. When impact is imparted on the motor, the lower surface 36a of the flange-like portion 36 is brought into contact with the upper surface 37a of the rotor slipping-off preventing means 37, thereby preventing the rotor from slipping off.

The motor of Fig. 2 has the following advantages because of its technical feature not using the rotor slipping-off preventing means. If the radial bearing of the Fig. 2 motor has the axial length equal to that of the radial bearing of the Fig. 1 motor, the radial bearing 9 which is placed within the bearing housing 7 may be low in height. This leads to the thinned motor structure. Further, the upper end face 35 of the radial bearing 9 may be located below the flange-like portion 36 of the bearing housing 7. This feature provides a structure making it difficult for oil to flow out of the bearing housing 7.

In the present invention, the drawing process is used for shaping a metal sheet into the cup-like bearing housing with the bottom portion in order to firmly hold the radial bearing 9 and the stator core 5 with the bearing housing. Use of the cup shape of the bearing housing 7 eliminates the leakage of oil that is contained in the radial bearing 9 from its bottom portion. The resultant motor is high in reliability and long in lifetime. The gap 33 provided between the radial bearing 9 and the bearing housing 7 functions to prevent oil from leaking, and further may be used as a space for the replenishing of bearing oil at the time of assembling the rotor into the structure.

While the present invention has been described using specific embodiments, it should be understood that the invention may variously be modified, changed and altered within the true spirits of the invention.

In the present invention, the bearing housing, which is shaped like a cup, includes a cylindrical portion and a bottom portion closing one end of the cylindrical portion. Therefore, in the resultant motor, no bearing oil flows outside from the bottom portion of the bearing housing.

Shaping a metal sheet by drawing process forms the bearing housing. Therefore, the number of parts required is reduced. The unit form of the bearing housing eliminates the leakage of bearing oil out of the housing.

A gap, which may be utilized for an oil reservoir, is formed between the inner surface of the cylindrical portion of the bearing housing and the outer surface of the radial bearing. Provision of the gap prevents the bearing oil from leaking out of the bearing housing, elongates a lifetime of the motor, and allows bearing oil replenishment at the time of assembling the rotor into the structure.